

1. Subbasin Assessment – Watershed Characterization

The federal Clean Water Act (CWA) requires that states and tribes restore and maintain the chemical, physical, and biological integrity of the nation's waters. States and tribes, pursuant to Section 303 of the CWA, are to adopt water quality standards necessary to protect fish, shellfish, and wildlife while providing for recreation in and on the waters whenever possible. Section 303(d) of the CWA establishes requirements for states and tribes to identify and prioritize waterbodies that are water quality limited (i.e., waterbodies not meeting water quality standards). States and tribes must periodically publish a priority list of impaired waters, currently every four years. For waters identified on this list, states and tribes must develop a total maximum daily load (TMDL) for the pollutants, set at a level to achieve water quality standards. This document addresses waterbodies in American Falls Subbasin that have been placed on the 1998 "303(d) list."

The overall purpose of this subbasin assessment and TMDL is to characterize and document pollutant loads within American Falls Subbasin. The first portion of this document, the subbasin assessment, is partitioned into four major sections: watershed characterization, water quality concerns and status, pollutant source inventory, and a summary of past and present pollution control efforts (Chapters 1 – 4, respectively). This information is then used to develop a TMDL for each pollutant of concern for the American Falls Subbasin (Chapter 5).

1.1 Introduction

In 1972, Congress passed the Federal Water Pollution Control Act, more commonly called the Clean Water Act (CWA). The goal of this act was to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters" (Water Pollution Control Federation 1987). The act and the programs it has generated have changed over the years as experience and perceptions of water quality have changed. The CWA has been amended 15 times, most significantly in 1977, 1981, and 1987. One of the goals of the 1977 amendment was protecting and managing waters to ensure "swimmable and fishable" conditions. This goal, along with a 1972 goal to restore and maintain chemical, physical, and biological integrity, relates water quality with more than just chemistry.

Background

The federal government, through the U.S. Environmental Protection Agency (EPA), assumes the dominant role in defining and directing water pollution control programs across the country. The Department of Environmental Quality (DEQ) implements the CWA in Idaho, while EPA oversees Idaho's program and certifies the fulfillment of CWA requirements and responsibilities.

Section 303 of the CWA requires DEQ to adopt, with EPA approval, water quality standards and to review those standards every three years. Additionally, DEQ must monitor waters to identify those not meeting water quality standards. For those waters not meeting standards, DEQ must establish TMDLs for each pollutant impairing the waters. Further, the agency must set appropriate controls to restore water quality and allow the

waterbodies to meet their designated uses. These requirements result in a list of impaired waters, called the 303(d) list. This list describes waterbodies not meeting water quality standards. Waters identified on this list require further analysis. A subbasin assessment and TMDL provide a summary of the water quality status and allowable TMDL for waterbodies on the 303(d) list. American Falls Subbasin Total Maximum Daily Load Plan: Subbasin Assessment and Loading Analysis provides this summary for the currently listed waters in American Falls Subbasin.

The subbasin assessment section of this report (Chapters 1 – 4) includes an evaluation and summary of current water quality status, pollutant sources, and control actions for impaired waterbodies in American Falls Subbasin to date. While this assessment is not a requirement of the TMDL, DEQ performs the assessment to ensure impairment listings are timely and accurate. The TMDL is a plan to improve water quality by limiting pollutant loads. Specifically, a TMDL is an estimation of the maximum pollutant amount that can be present in a waterbody while still allowing that waterbody to meet water quality standards (Water quality planning and management, 40 CFR 130). Consequently, a TMDL is waterbody- and pollutant-specific. The TMDL also includes individual pollutant allocations among various sources discharging the pollutant. EPA considers certain unnatural conditions, such as flow alteration, lack of flow, or habitat alteration, as “pollution” as long as they are not the result of the discharge of a specific pollutant (e.g., sediment, nutrients). TMDLs are not required for waterbodies that are impaired by pollution, but not specific pollutants. In common usage, a TMDL also refers to the written document containing the statement of loads and supporting analyses, often incorporating TMDLs for several waterbodies and/or pollutants within a given watershed.

Idaho's Role

Idaho adopts water quality standards to protect public health and welfare, enhance the quality of water, and protect biological integrity. A water quality standard defines the goals of a waterbody by designating the use or uses for the water, setting criteria necessary to protect those uses, and preventing degradation of water quality through antidegradation provisions.

The state may assign or designate beneficial uses for particular Idaho waterbodies to support. These beneficial uses are identified in Idaho water quality standards and include:

- Aquatic life support – coldwater, seasonal coldwater, warmwater, salmonid spawning, modified
- Contact recreation – primary (swimming), secondary (boating)
- Water supply – domestic, agricultural, industrial
- Wildlife habitat, aesthetics

The Idaho legislature designates uses for waterbodies. Industrial water supply, wildlife habitat, and aesthetics are designated beneficial uses for all waterbodies in the state. If a waterbody is

unclassified, then coldwater and primary contact recreation are used as additional default designated uses when waterbodies are assessed.

A subbasin assessment entails analyzing and integrating multiple types of waterbody data, such as biological, physical/chemical, and landscape data to address several objectives:

- Determine the degree of designated beneficial use support of the waterbody (i.e., attaining or not attaining water quality standards).
- Determine the degree of achievement of biological integrity.
- Compile descriptive information about the waterbody, particularly the identity and location of pollutant sources.
- When waterbodies are not attaining water quality standards, determine the causes and extent of the impairment.

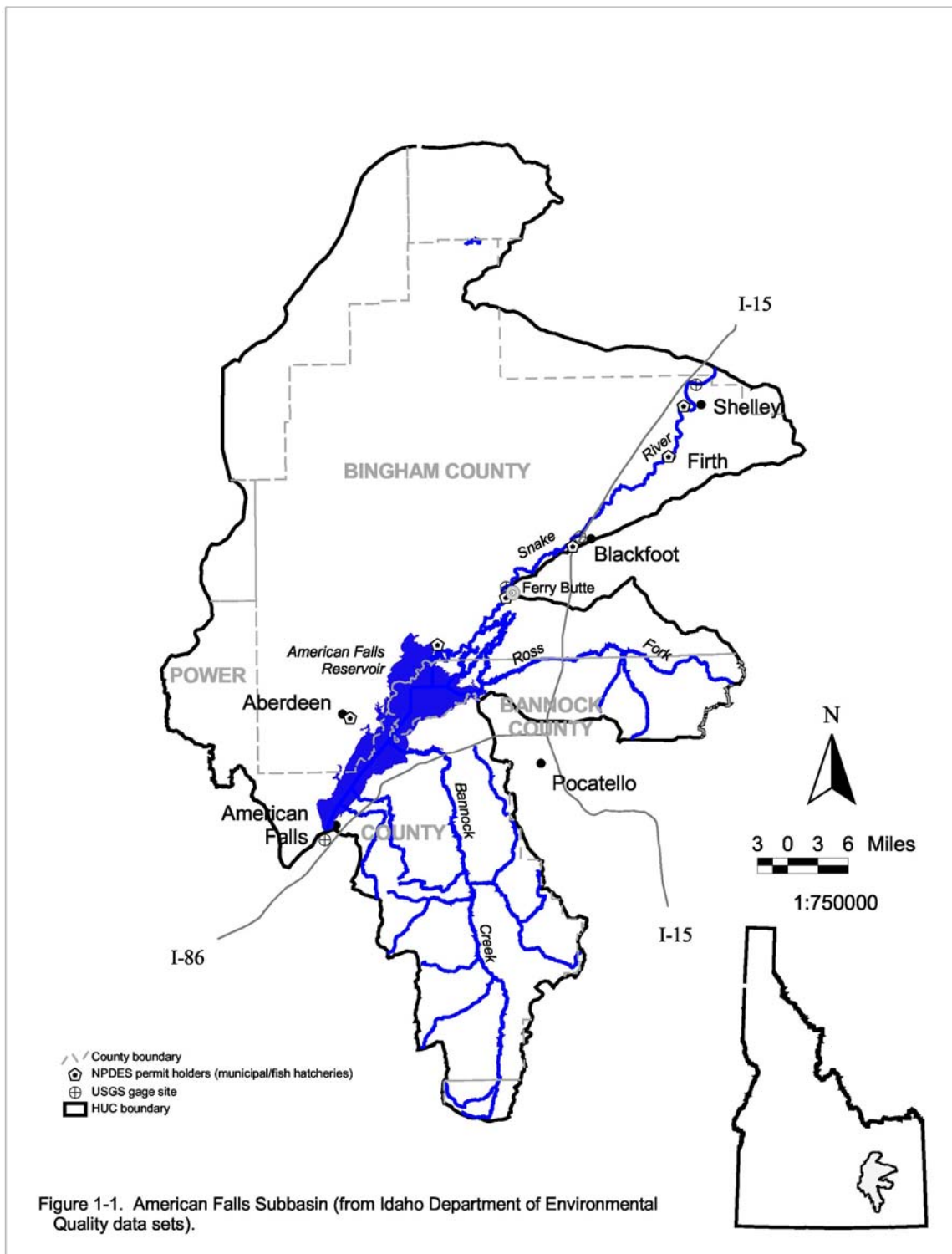
While the Shoshone-Bannock Tribes can establish specific water quality standards for waterbodies (e.g., portions of Bannock Creek and its tributaries) within the Fort Hall Reservation, they have not gone through the formal process to do so at this time. For the purposes of the American Falls Subbasin TMDLs, existing State of Idaho water quality standards will be used as the basis for water quality targets for Bannock Creek and its tributaries.

1.2 Physical and Biological Characteristics

Geography

American Falls Subbasin covers 2,869 square miles (1.8 million acres, 0.75 million hectares) in southeast Idaho (Figure 1-1). The main feature is American Falls Reservoir, with American Falls Dam marking the downstream boundary of this subbasin. The subbasin also includes Snake River from the reservoir to Bingham-Bonneville county line, the upstream boundary of the subbasin. Other significant tributaries within the subbasin include Spring Creek, McTucker Creek, Danielson Creek, Bannock Creek, and Ross Fork. While Blackfoot and Portneuf rivers are also tributaries to Snake River and American Falls Reservoir, respectively, these waterbodies lie within their own subbasins.

Although the Snake River Plain is the dominant geographic feature in the subbasin, higher elevations occur in Ross Fork and Bannock Creek watersheds. South Putnam Mountain rises to 8,950 ft above mean sea level (NOTE: all elevations will be above mean sea level) in Ross Fork watershed, and Deep Creek Peak in Bannock Creek watershed reaches an elevation of 8,747 ft. The lowest elevation in the subbasin is about 4,250 ft at the base of American Falls Dam.



Climate

Much of the subbasin's semi-arid climate is the result of the Cascade and Sierra mountains to the west and the Bitterroot and Rocky mountains to the north, which effectively block Pacific moisture (Idaho Power Company Web site). The temperature moisture regimes are frigid and mesic/aridic (EPA et al. 2000). Data from four weather stations (near American Falls, Aberdeen, Arbon, and Blackfoot) indicate average annual temperature is about 7.7°C (46°F; Table 1-1). Highest temperatures occurred in July and August, and highest precipitation at these stations was in May, with lowest precipitation occurring during summer months. Annual precipitation ranged from 22.3 cm (8.8 in) at Aberdeen to 40.7 cm (16.0 in) at Arbon. On an annual basis, the percentage of sunshine at Pocatello averages 64%. Local agriculture is dependent on snowmelt in April and May, summer thunderstorms, and groundwater irrigation for ensuring adequate moisture for raising crops.

Subbasin Characteristics

American Falls Subbasin straddles two ecoregions. More than three-fourths of the subbasin is in the Snake River Plain Ecoregion (Table 1-2), which is part of the xeric intermontane west (EPA et al. 2000). Most of the subbasin is unglaciated containing nearly level river terraces, floodplains, and lake plains (EPA et al. 2000). Geology consists of quarternary mixed alluvium, lake deposits (from the ancient Bonneville flood), and basalt bedrock, common to the eastern Snake River plain. Subbasin soils are mollisols, entisols, and aridisols. Potential natural vegetation is mostly sagebrush and saltbush-greasewood. In riparian areas, potential natural vegetation includes sedges, perennial grasses, willows, and cottonwood.

The southern part of the subbasin, including most of Bannock Creek watershed is in the Northern Basin and Range Ecoregion (Table 1-2). Plains and mountains typify this ecoregion, and livestock grazing occurs throughout the watershed. Potential natural vegetation includes sagebrush, saltbush, and greasewood. Aspen, lodgepole pine, and Douglas-fir are supported in alluvial fans and along drainages.

Potential native vegetation along Snake River above the reservoir is typical of wet or semi-wet meadow complexes consisting of sedges, rushes, shrubby cinquefoil, willows, dogwood, and black cottonwood (USDA 1986 cited in Sampson et al. 2001). Sampson et al. (2001) observed Reed's canary grass, cottonwood, willows, Russian olive, red osier dogwood, snowberry, golden currant, hawthorn, and skunkbrush sumac in their study of Snake River above the reservoir.

The natural vegetation of Bannock Creek watershed typically consists of a shrub overstory with an understory of perennial grasses and forbs. Basin big sagebrush may be on sites having deep soils or accumulations of surface sand (Shumar and Anderson 1986). Other common shrubs include gray rabbitbrush, winterfat, spiny hopsage, prickly phlox, broom snakeweed, and horse-brush. Utah juniper, threetip sagebrush, and/or black sagebrush often dominate peripheral communities on slopes of buttes, alluvial fans, and foothills of adjacent mountains.

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Table 1-1. Climatological data from sites in and near American Falls Subbasin.

Site	Period of record	Month												Annual
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Mean monthly temperature (°C)														
American Falls 1 SW	1948-2003	-4.0	-1.3	3.1	8.1	12.8	17.2	21.6	20.8	15.8	9.4	2.4	-2.7	8.6
Aberdeen Experiment Station	1914-2003	-6.1	-3.0	1.7	6.9	11.8	16.1	20.4	19.3	13.9	7.9	0.9	-4.4	7.1
Arbon 2 NW	1962-2002	-5.4	-3.0	1.5	6.3	11.1	15.5	19.9	19.4	14.2	8.1	0.9	-4.8	7.0
Blackfoot 2 SSW	1948-2003	-4.9	-2.1	2.6	7.7	12.6	16.9	20.9	20.0	15.1	8.7	1.5	-4.2	7.9
Average total precipitation (centimeters)														
American Falls 1 SW	1948-2003	2.7	2.1	2.7	2.8	3.7	2.4	1.3	1.5	1.8	2.1	2.7	2.5	28.2
Aberdeen Experiment Station	1914-2002	1.8	1.6	1.8	2.1	2.8	2.3	1.2	1.2	1.7	2.0	1.8	1.9	22.3
Arbon 2 NW	1962-2002	4.1	3.6	3.8	3.7	4.4	3.5	2.4	2.3	2.4	2.7	3.8	4.2	40.7
Blackfoot 2 SSW	1948-2002	2.3	2.0	2.3	2.4	3.2	2.6	1.2	1.2	1.7	1.8	2.3	2.3	25.3
Average total snowfall (centimeters)														
American Falls 1 SW	1948-2003	23.1	11.9	7.9	3.3	1.0	0.0	0.0	0.0	0.0	3.3	6.9	17.8	75.4
Aberdeen Experiment Station	1914-2002	16.3	9.4	5.1	3.6	0.3	0.0	0.0	0.0	0.0	1.3	4.1	12.2	52.1
Arbon 2 NW	1962-2002	34.3	25.4	13.0	4.3	0.8	0.0	0.0	0.0	0.3	1.8	16.5	32.8	128.8
Blackfoot 2 SSW	1948-2002	17.0	10.4	5.8	2.3	0.0	0.0	0.0	0.0	0.0	1.8	6.1	16.3	59.7
Mean percent of possible sunshine														
Pocatello	NA ¹	40	53	61	66	67	75	83	81	80	71	46	40	64

¹NA=not available

Table 1-2. Characteristics of ecoregions in American Falls Subbasin (modified from Maret et al. 1997 and Omernik and Gallant 1986).

Ecoregion	Percentage of surface area	Land surface form	Potential natural vegetation	Land use	Soils
Snake River Basin/High Desert	76	Tableland with moderate to high relief; plains with hills or low mountains	Sagebrush steppe (sagebrush, wheatgrass, saltbush, and greasewood)	Desert shrubland grazed; some irrigated agriculture	Aridisols, aridic mollisols
Northern Basin & Range	24	Plains with low to high mountains; open high mountains	Great Basin sagebrush, saltbush, and greasewood	Desert shrubland, grazed	Aridisols

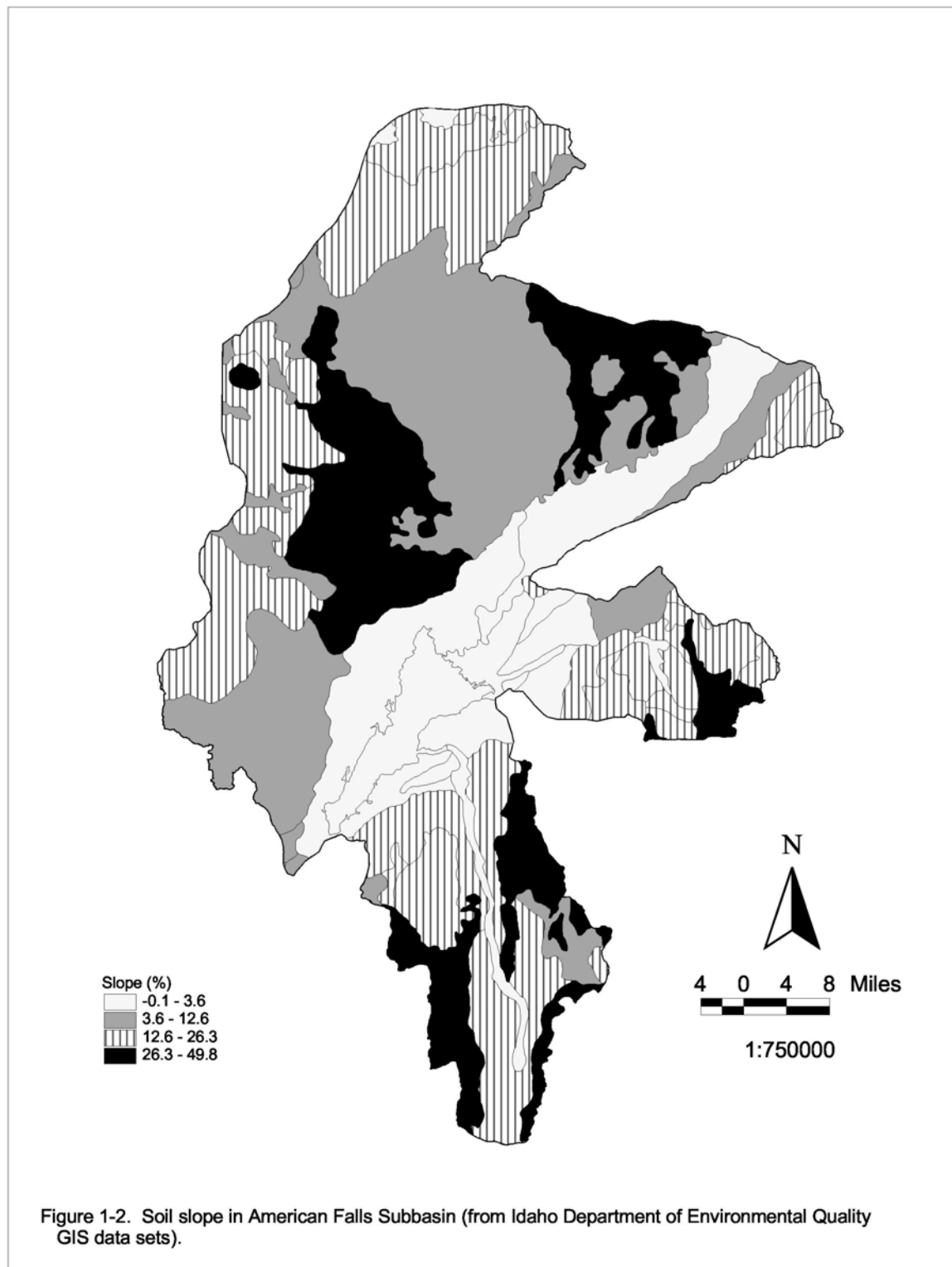
The most common native grasses in Bannock Creek watershed include thick-spiked wheatgrass, bottlebrush squirreltail, Indian ricegrass, needle-and-thread grass, and Nevada bluegrass. Patches of creeping wildrye, and western wheatgrass are locally abundant. Bluebunch wheatgrass is rare at lower elevations but common along the eastern side of the drainage. It is often the dominant grass on alluvial fans and slopes of buttes and foothills. There are no known threatened or endangered (T&E) aquatic plant species within Bannock Creek watershed (INEEL Environmental Surveillance, Education and Research Program Web site).

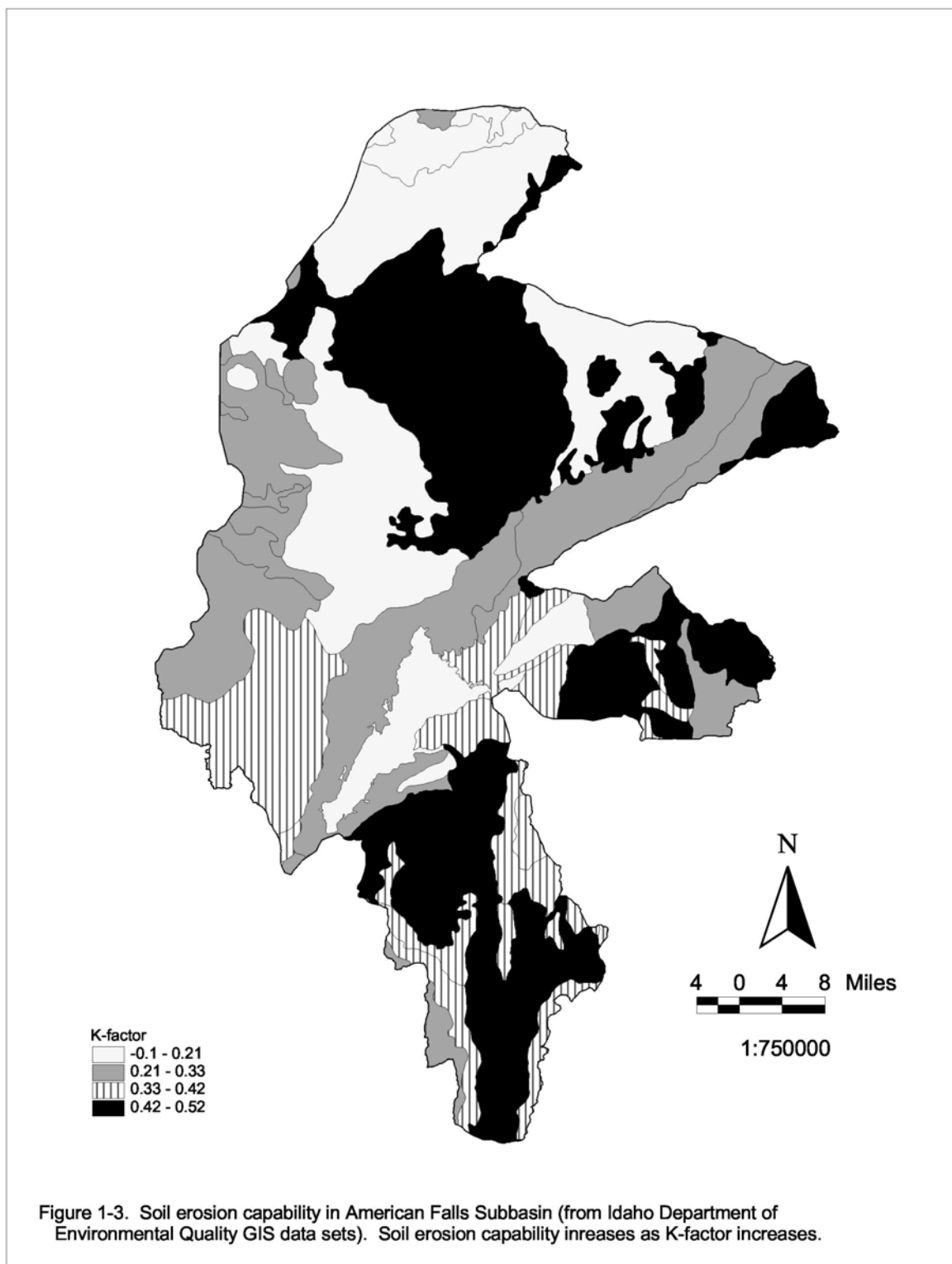
Soil slope is lowest along Snake River and increases as distance from the river increases. Slope is less than about 4%, generally in areas adjacent to the reservoir and river (Figure 1-2). Areas of slope greater than 26% occur in the headwaters of Bannock Creek and Ross Fork, and in the northern part of the basin. The soil type and steep slopes cause soil erosion to be a significant problem in Bannock Creek watershed. The most highly erodible soils are found in Bannock Creek and Ross Fork watersheds and in a large part of the lava area in the northern part of the subbasin (Figure 1-3). Areas with lowest soil erodibility potential are located along the Snake River and western edge of the subbasin.

Snake River Plain Ecoregion streams generally have higher primary productivity than streams with forest canopy overstory (EPA et al. 2000). Natural fish assemblages include both mesothermal (intermediate [6-22°C] temperature favoring) species such as minnows and suckers as well as stenothermal (tolerant of a narrow range of temperatures) salmonid and sculpin species.

The historic fish community in the subbasin consisted of suckers, chubs, daces, salmonids, and sculpins. Yellowstone cutthroat trout and mountain whitefish were the only native salmonids found in the subbasin. Introduced salmonids include rainbow trout, brook trout, and brown trout. Other introduced species are common carp, bullhead, smallmouth bass, black crappie, and yellow perch. Sampson et al. (2001) listed rainbow trout, cutthroat trout, rainbow x cutthroat trout hybrids, sculpins, suckers, yellow perch, and smallmouth bass present in Snake River above the reservoir. Other species, which have been reported in the reservoir, include kokanee, white crappie, black crappie, largemouth bass, black bullhead, brown bullhead, yellow perch, Utah chub, speckled dace, and fathead minnow (Johnson et al. 1977, Heimer 1989).

U. S. Geological Survey (USGS) characterized fish assemblages in the upper Snake River Basin as part of their National Water Quality Assessment (NAWQA) Program (Maret 1997). Two sites were within American Falls Subbasin – Snake River near Blackfoot and Spring Creek near Fort Hall. Species common to both sites included Utah sucker, mottled sculpin, mountain whitefish, and rainbow trout. Common carp, longnose dace, and redbreasted sunfish were found only in Snake River. The only species collected in Spring Creek and not in Snake River was cutthroat trout. Further work by USGS in 2002 captured bluehead sucker, Utah sucker, mottled sculpin, Paiute sculpin, common carp, fathead minnow, longnose dace, redbreasted sunfish, speckled dace, brown trout, cutthroat trout, mountain whitefish, and rainbow trout during electrofishing sessions on Snake River at Shelley (Maret and Ott 2003).





Subwatershed and Stream Characteristics

The subbasin can be divided into four regions. American Falls Reservoir, Snake River, and Bannock Creek are considered watersheds; all other tributaries (e.g., McTucker Creek) have been lumped together and can be considered subwatersheds. The characteristics of each of these watersheds and streams are described in the following sections.

American Falls Reservoir Watershed

American Falls Reservoir is the largest reservoir in Idaho with a surface area of 56,055 acres at a pool elevation of 4,354.5 ft (Bushnell 1969). Storage capacity at elevation 4,354.5 ft is 1.67 million acre-feet (Bureau of Reclamation Web site a). There is about 100 miles of shoreline around the reservoir. Total drainage area to the reservoir, which includes area outside American Falls Subbasin, is 13,580 square miles.

The primary purpose of American Falls Reservoir is irrigation. Bureau of Reclamation (BOR) operates American Falls Reservoir as part of their Minidoka project, which includes Minidoka Dam, Jackson Lake Dam, Island Park Dam, and Grassy Lake Dam (Bureau of Reclamation Web site b). Refill typically starts in October and continues through winter and early spring (Heimer 1989). Final fill in average water years occurs during spring runoff. Irrigation season begins in June and the reservoir is drawn down as outflow exceeds inflow. This method of operation has changed the pre-dam hydrograph: spring flows are reduced while summer flows are increased for water delivery to downstream irrigators (Figure 1-4). Water fluctuations in the reservoir can vary widely depending on water year and irrigation demand as evidenced by reservoir storage in WY2003 compared to average storage from WY1970 to WY2000 (Figure 1-5).

In addition to Snake River, which enters American Falls Reservoir to the northeast, Portneuf River, Spring Creek, McTucker Creek, Danielson Creek, and Bannock Creek are the main tributaries. Other water entering the reservoir comes from springs, irrigation return water, and smaller tributaries. Snake River accounts for about 60% of the flow into the reservoir with Portneuf River and Spring Creek contributing about 7% and 5%, respectively (Table 1-3). From Ferry Butte to Neeley (below the dam), groundwater, via springs or direct flow, accounts for about 2,500 cfs annually (Kjelstrom 1995).

Fort Hall Bottoms are located at the northeast end of the reservoir on Fort Hall Indian Reservation, and this area is one of the largest reaches of intact, forested floodplain in the area (Sampson et al. 2001). Much of its rich diversity of animal and plant life is due to the proximity of Snake River.

Snake River Watershed

Snake River winds its way through the subbasin for about 55 miles (Table 1-4), widening in several areas as it flows around islands and through side channels. The meander belt width for the river below Ferry Butte is 2,000-3,000 feet (Sampson et al. 2001)

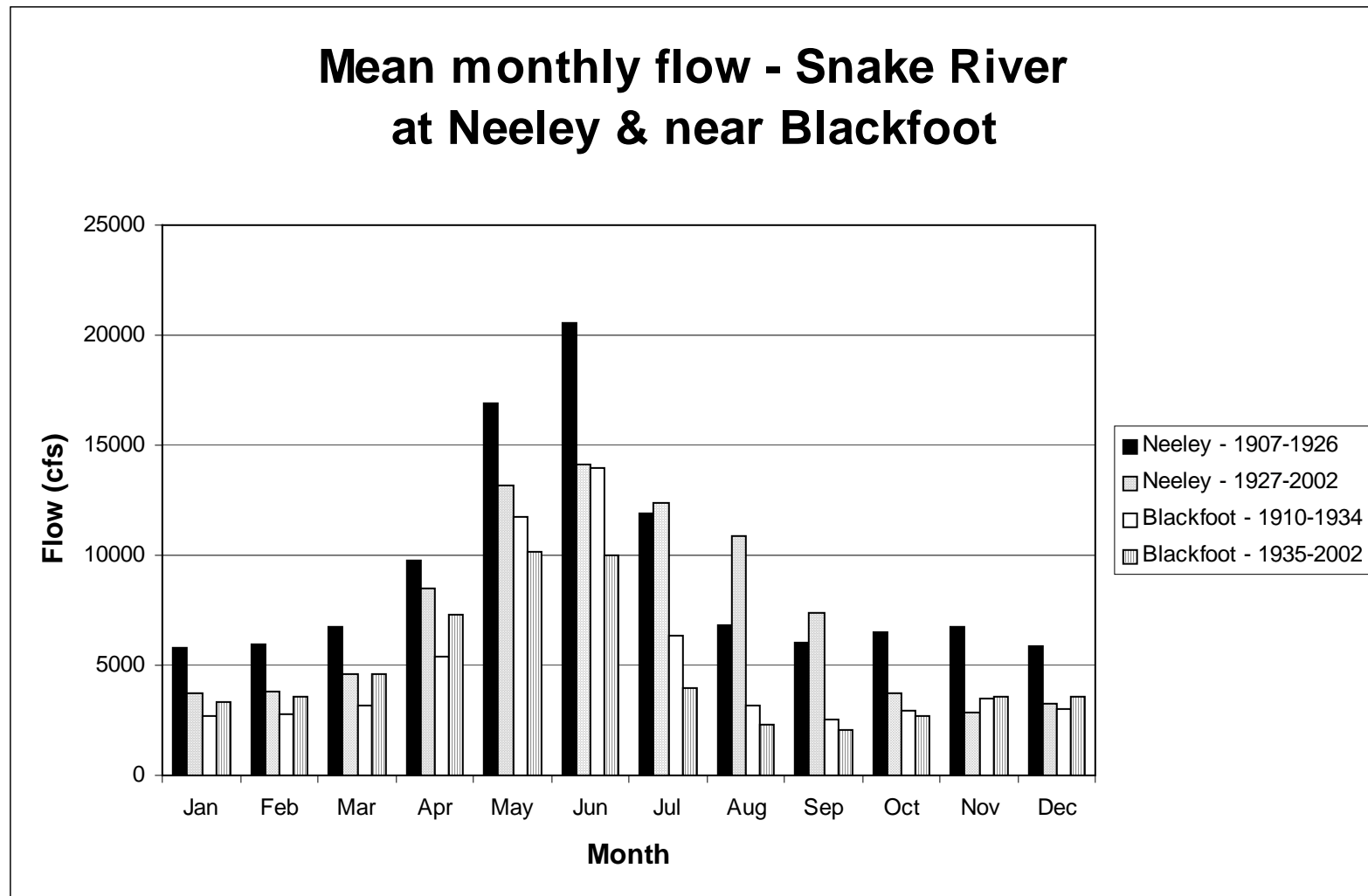


Figure 1-4. Mean monthly flows at USGS surface-water stations in the Snake River at Neeley (13077000) before and after construction of American Falls Dam and near Blackfoot (13069500) before and after construction of Island Park Dam

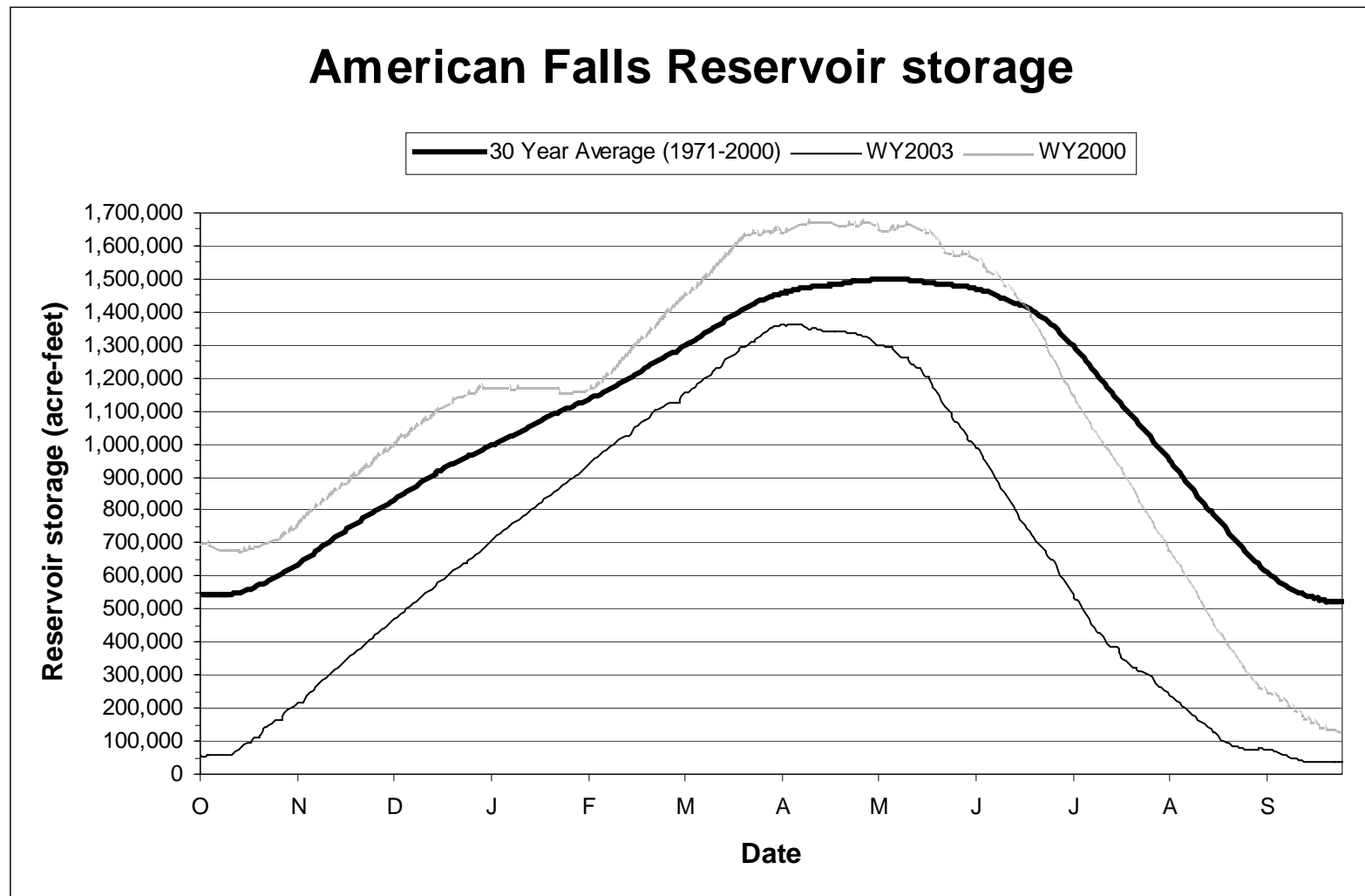


Figure 1-5. Storage capacity in American Falls Reservoir (from Bureau of Reclamation Web site c).

Table 1-3. Flow into American Falls Reservoir from various tributaries based on flow measured at USGS gage sites.

	Waterbody						
	Snake River at Neeley	Snake River near Blackfoot	Portneuf River at Pocatello ¹	Spring Creek	Danielson Creek	Bannock Creek	Ross Fork
Period of record (full years)	1908-1909, 1912-2002	1911-1915, 1917-2002	1913-1916, 1918-2002	1981-2002	1981, 1986-1988	1986-1994	1986-1994
Average total annual (WY) flow (cfs)	91,842	58,086	5,902	4,279	719	467	650
Standard deviation	27,668	26,510	1,265	344	61	240	180
Count	93	91	89	22	4	9	9
Percentage of flow into reservoir ²	100.0%	61.1%	6.8%	5.1%	0.8%	0.6%	0.9%
Standard deviation		12.1%	1.1%	1.6%	0.3%	0.1%	0.1%

¹as Portneuf River at Pocatello gage had a longer period of record, and to account for additional flow below the gage attributable to Portneuf River, a comparison of 10 years of data (WY 1986-1994, 2002) showed that Tyhee averaged 2560 cfs (standard deviation=180 cfs) more per year, so that amount was added to annual flows measured at Pocatello

²percentage of flow based on average of annual comparison to flow at Snake River at Neeley gage, which was assumed to represent entire flow into reservoir

Table 1-4. Physical data, land use, and land ownership of waterbodies in American Falls Subbasin.

Waterbody	Length (miles)	Drainage area (acres)	Gradient	Begin elevation (ft)	End elevation (ft)	Land use (acres)										Land ownership					
						Irrigated agriculture gravity flow	sprinkler	Dryland agriculture	Rangeland	Forest	Riparian	Water	Rock	Urban	Private	Shoshone- Bannock Tribes	Bureau of Land Management	Forest Service	Open water	State of Idaho	
American Falls Reservoir ¹		8,691,165																			
Snake River ²	56.6	7,238,371	0.1%	4,630	4,320																
McTucker Creek ³	2.24		0.3%	4,375	4,340																
Bannock Creek	53.1	264,869	0.4%	5,520	4,350	3,963	9,481	95,823	105,694	48,420	393	231		866	152,057	63,211	40,751	7,030	19	1,801	
Moonshine Creek	9.68	28,863	2.6%	6,080	4,740			6,114	11,750	11,000					5,796	17,650	5,359			59	
Rattlesnake Creek	18.7	52,515	1.9%	6,530	4,700			23,740	19,032	9,744					33,608	3,492	8,715	5,733		967	
West Fork Bannock Creek	7.09	9,640	5.6%	7,040	4,930	362		330	1,676	7,273					3,418	480	5,743				
Knox Creek	7.82 ⁴	14,920	1.6%	5,700	5,020		264	4,939		9,717					6,479		7,799			642	

¹most of the drainage area of American Falls Reservoir is outside the subbasin

²most of the drainage area of the Snake River is outside the subbasin, listed drainage area is at USGS surface-water station near Blackfoot (13069500)

³as McTucker Creek is a spring stream and relatively flat, it is difficult to establish a drainage area. Land use looks to be near 100% sprinkler irrigated land. Visual estimation of ownership is 67% private and 33% Bureau of Land Management.

⁴from confluence of right and left forks of Knox Creek

Sampson et al. (2001) noted five large-scale changes that have affected Snake River from Ferry Butte to American Falls Reservoir:

- 1) Construction of American Falls Dam created backwater areas of the reservoir that caused a flattening of the river.
- 2) Changes from flood to sprinkler irrigation have decreased sediment loads.
- 3) Additional dam construction and river management have introduced flow modifications.
- 4) The flow regime has become more variable.
- 5) The declining presence of young woody plants (e.g., cottonwood, willow, dogwood) has resulted in a change in vegetative composition.

These changes have resulted in the upper section of the reach becoming more sinuous due to decreased annual sediment load, increased low flow volumes, and decreased peak flows. In contrast, the downstream section is becoming straighter with more branching and less sinuosity due to a localized flattening of the energy grade line.

Numerous water diversions occur along this stretch of Snake River (Table 1-5). A quick comparison of Snake River flow near Shelley and near Blackfoot shows losses of up to 3,151 cfs during the irrigation season of April to October (Table 1-6). The losses shown by Table 1-6 represent absolute change in flow between the Snake River near Shelley and near Blackfoot gages. This absolute change includes both losses from irrigation diversions, evapotranspiration, groundwater infiltration (Kjelstrom 1995), as well as gains from the Blackfoot River, irrigation returns, and spring flow. One of the largest users of Snake River water in the subbasins is the Aberdeen-Springfield Canal Company. The canal diverted an average of 590 cfs during the 1981 irrigation season from April to October (USGS Web site).

USGS maintains three gage sites along this reach of Snake River (Figure 1-1). Gages are located, and named accordingly, near Shelley, at Blackfoot, and near Blackfoot (actually at Ferry Butte and Tilden Bridge). Data from these gages indicate that Snake River from Shelley to Ferry Butte is a losing reach of stream despite input from springs in the lower end of the reach (Kjelstrom 1995). From Ferry Butte to Neeley, the Snake River gains about 2,500 cfs from ground water on an annual basis. Ground water discharge from the Portneuf River is about 1,650 cfs, accounting for 66% of the gain in flow from Ferry Butte to Neeley. In addition to Portneuf River, Blackfoot River (average total annual flow 1,867 cfs; Brennan et al. 2003) also enters Snake River in this reach just upstream of Ferry Butte.

Bannock Creek Watershed

Bannock Creek watershed, in the southern portion of American Falls Subbasin, is predominately located in the Northern Basin and Range Ecoregion. The creek drains an area of approximately 265,000 acres. The watershed encompasses portions of Bannock, Oneida, and Power counties, with 112,500 acres of the watershed contained within Fort Hall Indian Reservation. Sparsely populated Arbon Valley is situated within Bannock Creek watershed, with the city of Pocatello nearby to the northeast.

Table 1-5. Irrigation diversions in Snake River from
Bingham-Bonneville county line to American Falls Reservoir.

Diversion name
Reservation
Blackfoot
New Lava Side
R. C. Adams #1
R. C. Adams #2
Peoples
Aberdeen
Swid
Corbett
Nielson-Hansen
R. Lambert
K. Christensen
Riverside
Danskin
Trego
Jensen Grove
Monroc Blackfoot
Wearyrick
Watson
Parsons
Fort Hall Michaud

Table 1-6. Mean monthly flows from April to October (general irrigation season) at USGS gage sites on Snake and Blackfoot rivers, Water Years 1964 to 2002.

Site	Gage number	Flow (cfs)						
		April	May	June	July	August	September	October
Snake River near Shelley	13060000	8,823	12,964	13,010	7,881	5,249	4,347	3,686
Blackfoot River near Blackfoot ¹	13068500	198	233	183	117	133	133	202
Snake River near Blackfoot	13069500	8,177	10,837	10,269	4,847	2,899	2,562	3,061
Flow lost ²		844	2,361	2,924	3,151	2,483	1,919	826

¹Blackfoot River enters Snake River just upstream of the Snake River near Blackfoot gage site

²flow lost=flow at Snake River near Shelley plus flow at Blackfoot near Blackfoot minus flow at Snake River near Blackfoot

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Elevation change in Bannock Creek watershed is almost 4,000 ft. The valley floor of the gently rolling terrain of the watershed has land-surface elevations ranging from 5,300 feet above sea level in the south to approximately 4,400 feet near Bannock Creek-American Falls Reservoir confluence. Mountain peaks and ranges border Bannock Creek to the west and east, physically delineating this watershed from adjacent watersheds. The Deep Creek Mountains flank the western edge and the Bannock Range the eastern edge of the watershed. The maximum elevation is Bannock Peak, which rises to 8,256 feet in the Deep Creek Mountains (Spinazola and Higgs 1998).

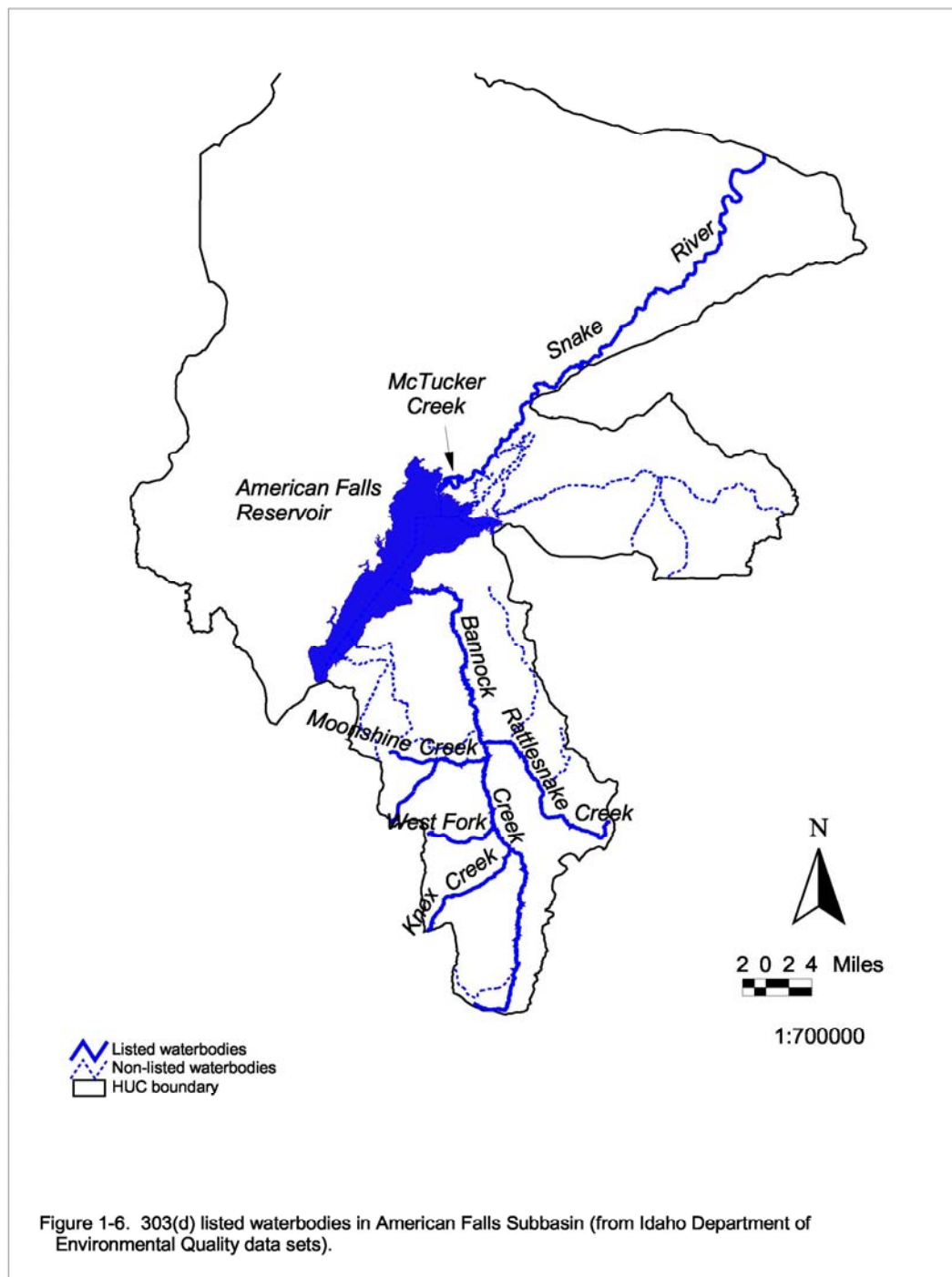
Bannock Creek flows almost due north approximately 50 miles to American Falls Reservoir, and is the major stream in the watershed (Figure 1-6, Table 1-4). Other important tributaries to Bannock Creek include Moonshine Creek, Rattlesnake Creek, West Fork, and Knox Creek (Figure 1-7). Rattlesnake Creek, the largest of the tributaries, has a drainage area of 52,500 acres and a stream length of 18.7 miles, draining much of the eastern section of the watershed (Spinazola and Higgs 1998). Moonshine Creek has a drainage area of 29,900 acres and Knox Creek has a drainage area of 14,900 acres. The West Fork Bannock Creek tributary to Bannock Creek, originates from a group of springs on the western section of the watershed and has the smallest drainage area at 9,640 acres. The geology of Bannock Creek watershed has been significantly altered by tectonic activity and volcanism.

Physical characteristics and Beneficial Use Reconnaissance Program (BURP)

Beneficial Use Reconnaissance Program (BURP) monitoring was completed by DEQ in Bannock Creek watershed and along tributaries to Bannock Creek outside of the Fort Hall Indian Reservation. Monitoring on Bannock Creek was limited to one site because of access constraints. BURP monitoring verified high levels of sediment loading in the streambed surface (Table 1-7) and no riffles or runs were found at the site. Stream bank cover of the site was ranked as good and bank stability at the site was rated as fair to good.

Additional BURP monitoring results are limited to portions of Rattlesnake Creek (including Rattlesnake Creek tributaries Midnight Creek and Crystal Creek) and Knox Creek subwatersheds outside of Fort Hall Indian Reservation. The headwaters of Crystal Creek originate on U. S. Forest Service (USFS) property and travel through state, Bureau of Land Management (BLM), private, and Shoshone-Bannock tribal lands before flowing into Rattlesnake Creek (USFS 2001). The overall gradient found in Rattlesnake Creek was 1.9% (Table 1-4) and pool-to-riffle ratios were low at both upper and lower Rattlesnake Creek BURP sites. Both monitoring sites in Rattlesnake Creek showed high levels of sediment (Table 1-7). Bank stability in Rattlesnake Creek was determined to be poor during the first monitoring event, but improved with time, shown from data taken during later monitoring events. Stream bank vegetative cover varied by site and year, but generally was fair to good.

Tributaries to Rattlesnake Creek, Midnight Creek and Crystal Creek, were higher gradient B-channel streams (Rosgen 1996) with a lower sinuosity than Rattlesnake Creek and had lower percent streambed surface fines – surface materials less than 2.5 mm along the shortest axis. (NOTE: percent streambed surface fines represent the percentage of streambed surface fines



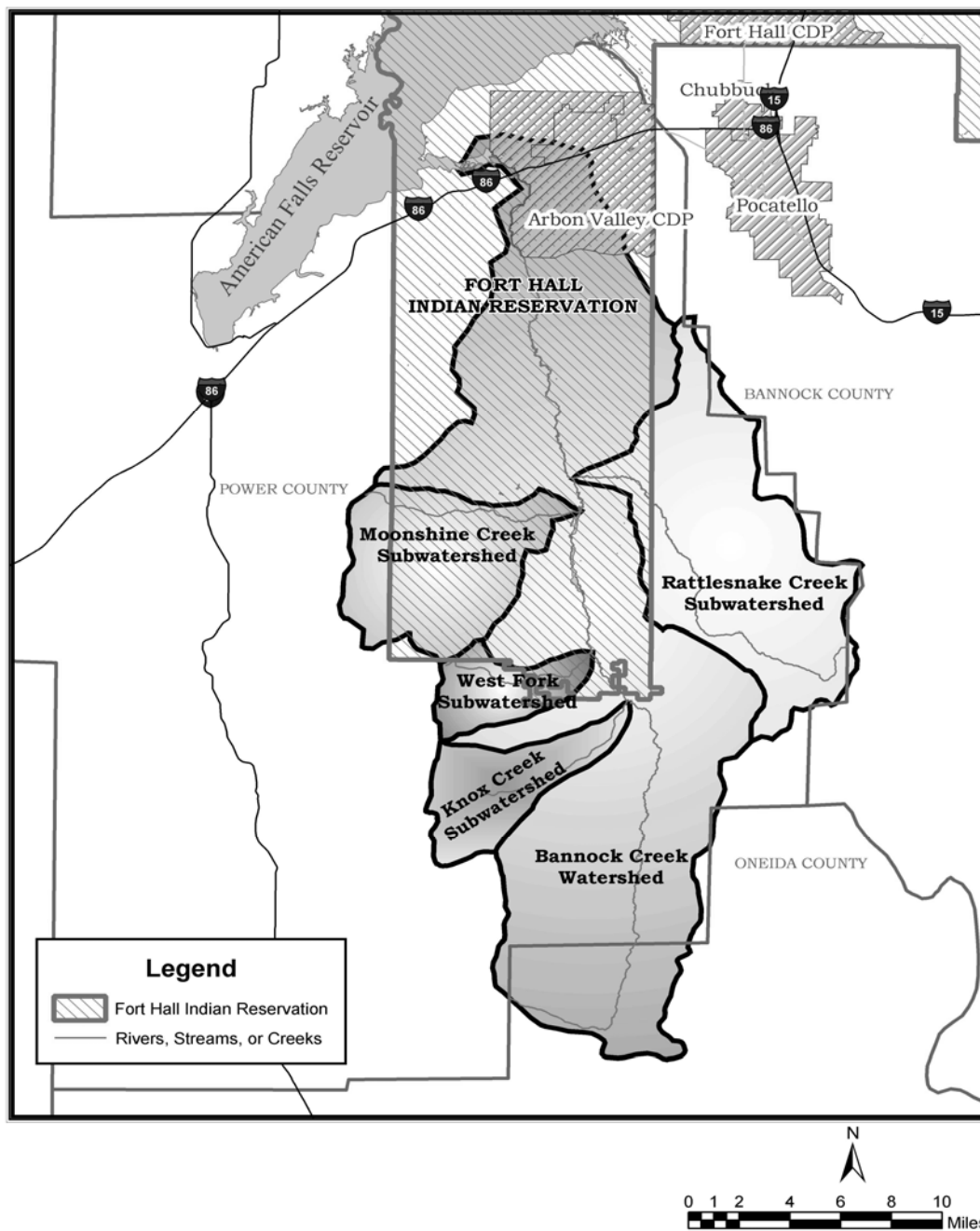


Figure 1-7. Bannock Creek watershed.

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Table 1-7. Watershed characteristics of tributaries in the American Falls Subbasin (from DEQ BURP data).

Waterbody	303(d) listed	Site	Date	Stream order	Site elevation (ft msl)	Valley type	Sinuosity	Gradient	Rosgen channel type	Percent fines < 2.5 mm (bankfull)	Pool: riffle ratio ¹	Width: depth ratio	Bank vegetation protection	Bank stability	Fish captured electrofishing
McTucker Creek	Y		31-Jul-96	1	4360	Trough-like	Moderate	1.25%	C	67.1%	0.6:1	33.6:1	87.0%	77.5%	rainbow trout, sculpin
			10-Jul-01	2	4330	Flat bottom	Moderate	1.0%	C	55.1%	1.2:1	23.1:1	98.5%	97.0%	
Bannock Creek	Y		11-Jun-96	1	5040	Trough-like	Moderate	0.5%	F	100.0%	AP ³	5.1:1	100.0%	96.0%	
			10-Jul-01	4	5040	Flat bottom	Moderate	0.5%	E	100.0%	AP ³	4:1	98.3%	65.5%	
Rattlesnake Creek	Y	Lower	17-Jun-96	2	4960	Trough-like	High	1.0%	F	100.0%	AP ³	8:1	77.5%	0.0%	
		Upper	10-Jun-96	1	5085	Trough-like	Moderate	2.0%	G	68.4%	0.9:1	3.9:1	78.0%	17.0%	
		Lower	9-Jul-01	2	5040	Flat bottom	Moderate	1.0%	E	99.0%	0:1	3.7:1	43.8%	51.3%	
		Upper	9-Jul-01	2	5680	Trough-like	Moderate	0.5%	C	64.3%	AR ²	2.9:1	97.0%	67.7%	
Knox Creek ⁴	Y		11-Jun-96	1	5750	V-shape	Low	3.0%	B	41.3%	AR ²	7.6:1	86.0%	0.0%	
			10-Jul-01	2	5750	Box canyon	Low								
Midnight Creek	N		17-Jun-96	1	5413	V-shape	Low	3.0%	B	28.0%	AR ²	12:1	88.5%	88.5%	
Crystal Creek	N		16-Jun-98	1	5360	V-shape	Low	3.5%	B	25.7%	AR ²	6.2:1	100.0%	100.0%	
Michaud Creek	N	Lower	30-Jun-97	2	4920	Trough-like	Low	2.0%	B	47.0%	AR ²	5.6:1	85.0%	85.0%	
		Upper	30-Jun-97	2	5560	V-shape	Low	3.0%	B	34.4%	AR ²	6.4:1	100.0%	100.0%	
Sunbeam Creek	N		16-Jun-98	1	4722	U-shape	Moderate	1.0%	F	43.6%	1.1:1	6.9:1	28.5%	23.5%	
			17-Jul-03	2	4780	NN ⁵	Moderate	3.0%	B	51.7%	0:1	6.5:1	80.0%	60.5%	
Danielson Creek	N		15-Jul-98	1	4400	Trough-like	Moderate	2.0%	F	76.7%	1.7:1	17.2:1	99.0%	99.0%	rainbow trout, sculpin, minnow
Hazard Creek (Little Hole Draw)	N		15-Jul-98	1	4370	Trough-like	Moderate	1.0%	C	25.4%	2.5:1	12.9:1	100.0%	100.0%	sucker, minnow
			17-Jul-03	3	4350	NN ⁵	Moderate	2.0%	G	36.1%	5.4:1	12.4:1	95.0%	89.5%	

¹ pool=pool or glide, run=riffle or run² all riffle or run, no pool or glide³ all pool or glide, no riffle or run⁴ stream dry in 2001⁵ none noted

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at bankfull level). No pools were observed along Rattlesnake Creek tributary monitoring sites in the BURP assessment. Stream bank vegetative cover and bank stability of Midnight and Crystal creeks were assessed as good. In August 2001, USFS conducted a one-day fish distribution survey on Midnight and Crystal creeks and recorded no flowing water on that date at the Fort Hall Reservation boundary (USFS 2001). Canopy cover was recorded as moderate with aspen and birch providing shade and root mass along banks. Sub-dominant vegetation consisted mostly of various species of grass and sedge.

Knox Creek is a higher order stream than Rattlesnake Creek and enters Bannock Creek much higher in the system (Figure 1-6). Sinuosity was low and gradient was 3% in the section of B-channel at the BURP site (Table 1-7). Percent streambed surface fines were about 40% and no pools were found at the site. Vegetative stream bank cover was good, but overall bank stability was very poor.

Soils

Soils of Bannock Creek watershed vary (Table 1-8). Average soil slope provides a gage of potential soil erosion or erodibility risk. In the valley, slopes are high (12-26%) and gradually increase towards the two bordering mountain ranges. Slopes are fairly steep (up to 49%) in the Bannock and Deep Creek mountains.

The K-factor is the soil erodibility factor in the Universal Soil Loss Equation. This factor is composed of four soil properties: texture, organic matter content, soil structure, and permeability. K-factor values range from 1.0 (most erosive) to 0.01 (nearly non-erosive). Weighted average K-factors are fairly low to moderate (0.21 to 0.52) for this watershed. In comparing K-factors for the watershed, values are lowest along the mountain ridges where unweathered bedrock and fragmented material are found. Soil erodibility in the valley and surrounding hillsides is fairly low to moderate with a K-factor range of 0.21 to 0.42.

Geomorphic Description

Riparian vegetation has an important effect on stream morphology and stream bank stability of certain stream types. Stream morphology also influences presence, amount, and potential for establishment of riparian vegetation communities (Rosgen 1996). Stream systems like those in Bannock Creek watershed characterized by high slopes, erosive soils, and intermittent high flows are dependent on riparian vegetation for stream bank stability. This interrelationship is very important to existing and potential conditions observed in Bannock Creek and its tributaries. In some areas, unmanaged overgrazing has shifted riparian communities that previously had significant components of intermediate sized woody/shrub species to primarily grass/forb communities. Additionally, with loss of bank stability and resultant straightening, stream channels can incise, lowering the water table adjacent to the stream, removing the streams access to its flood plain, and changing how the channel functions. Changes in composition, vigor, and density of riparian vegetation produce corresponding changes in rooting depth, rooting density, shading, water temperature, physical protection from bank

Table 1-8. Soil series in Bannock Creek watershed
(from STATSGO soils database for Idaho).

Soil series name	Acres
Chedehap	160.9
Water	278.8
Broncho	2,416.50
Arbone	2,478.90
Camelback	6,564.90
Portino	11,907.20
Burgi	13,253.50
Declo	16,832.40
Highams	19,399.60
Rexburg	20,731.80
Pocatello	22,983.50
Hondoho	24,255.40
Lanoak	30,196.00
Neeley	92,934.10

erosion processes, terrestrial insect habitat, and contribution of detritus to the channel (Rosgen 1996).

Wildlife

Power County, in which Bannock Creek watershed lies, has over 80 different species of mammals, over 70 species of birds associated with waterbodies throughout the county, and over 140 song bird species. Federally listed threatened or endangered species potentially occurring within the Bannock Creek watershed include peregrine falcon and bald eagle (Idaho Power Company Web site).

Other tributaries

McTucker Creek is a small (slightly greater than two miles in length), low gradient (about 0.3%) stream originating from springs located in the Snake River floodplain near where the river enters American Falls Reservoir (Table 1-4, Figure 1-6). DEQ has monitored the stream as part of its BURP effort (Table 1-7). BURP data indicated the C-channel stream was wide with a low number of pools. The percentage of fines on the surface of the streambed was high at over 67%. Bank stability and bank cover were generally good. Rainbow trout were present at this popular fishing site.

In addition to McTucker Creek, BURP monitoring occurred on Danielson Creek and Hazard Creek/Little Hole Draw, which empty into the reservoir on the north and west side, and Sunbeam Creek, located in the southern part of the subbasin west of Bannock Creek watershed. Danielson and Sunbeam creeks were higher order streams as compared to Hazard Creek/Little Hole Draw (Table 1-7). Sinuosity was moderate for all three streams. Percent streambed surface fines were highest in Danielson Creek at over 75% and lowest in Hazard Creek/Little Hole Draw at about 30%. Incidence of pools was lowest in Sunbeam Creek and highest in Hazard Creek/Little Hole Draw. Danielson Creek had the highest width to depth ratio. Stream bank vegetative cover and stability were good in Danielson Creek and Hazard Creek/Little Hole Draw, and had improved substantially between sampling events in Sunbeam Creek.

1.3 Cultural Characteristics

This area is rich in history beginning with Native American habitation. Land use and cultural features are also discussed in this subsection.

History

The history of Native Americans in the area is described by Stene (1997):

Two Native American groups inhabited southeastern Idaho prior to 19th century immigration by Europeans. The Bannocks, a Northern Paiute speaking people, migrated

from Oregon to the Snake River plains. They differed from other Northern Paiutes by their acquisition of horses and organized buffalo hunts. The Bannocks co-existed peacefully in

Idaho with the Northern Shoshone. Native grasses supported buffalo in the upper Snake River plains until about 1840. Fish also contributed largely to both Native American groups' subsistence.

The Bannocks and the various groups of the Shoshone found themselves placed on reservations starting in the late 1860s. The Federal government originally set up the Fort Hall Indian Reservation in 1867, for the Boise and Bruneau Shoshone, with eventual relocation of the Bannock and other Shoshone to the reservation in accordance with the Fort Bridger Treaty of 1868.

Hatzenbuehler (2002) describes the arrival of the first European-American settlers:

The first permanent European-American settlements began in the 1860s, when members of the Church of Jesus Christ of Latter-Day Saints moved northward from Cache Valley, Utah, into Idaho Territory . . . followed . . . in subsequent years by settlements along the Bear River Valley, the Malad River, and Goose, Warm and Rock creeks and Raft River. Large-scale settlement of Idaho and other western states came with introduction of the railroad. The Railroad Act of 1862 set the stage for the entry of railroad development in the West, and in 1869 the transcontinental railroad was completed . . . In 1881, Union Pacific Rail Road announced plans to build a main line across Idaho, from east to west, to eventually reach the Pacific coast.

The railroad brought both people and an expansion of economic activity to Idaho; in addition to the railroad, large-scale irrigation projects helped settle the Snake River Plain, as described by Link and Phoenix (1996):

The American Falls Project of the Bureau of Reclamation, successor to the Reclamation Service, built in the 1910s and 1920s, assured late-season water for small cooperatives on the upper Snake, the thousands of farmers in the Twin Falls and North Side projects and the Minidoka Project. In later years, expansion of the American Falls Project required the removal of the town of American Falls to higher ground because a new dam would flood the old town. This large concrete structure created a reservoir of 1.7 million acre-feet, to bring into cultivation an additional 115,000 acres in the vicinity of Gooding and provided supplemental water for over one million acres above and below the facility. Construction began in 1925, and the gates were closed upon completion in October, 1926. The reservoir first reached its maximum storage size on July 1, 1927.

American Falls Reservoir flooded some lands of Fort Hall Indian Reservation (Bureau of Reclamation 1921 cited in Stene 1997). BOR negotiated with the Indian Service, later the Bureau of Indian Affairs, to appraise the reservation lands for purchase. In addition to flooding the lands, some people feared the reservoir would engulf Fort Hall itself. Fort Hall escaped flooding, but in 1993 BOR preservation officers debated the erosion threat to the fort, and it was listed as an endangered site.

By the early 1970s, American Falls Dam began showing increasing signs of deterioration (Bureau of Reclamation 1974 and 1980 and John Dooley, personal communication, all cited in Stene 1997). BOR and the American Falls Reservoir District No. 2 reached an agreement in 1973 to replace the dam through private funds. Construction preparations began in 1974, and in 1977 BOR breached the old American Falls Dam, and began storing water behind the new dam. Workers finished most of the new American Falls Dam in 1978.

Today American Falls Dam, along with the other parts of the Minidoka Project, plays an important role in the agriculture base of southern Idaho (Idaho Public Television Web site). The main crops in this area are alfalfa and potatoes and, to a lesser extent, apples, barley, beans, sugar beets, corn, hay, onions, pears, peas, prunes, and rye are also grown. In 1992 1,062,093 acres were irrigated, producing \$462,684,605 worth of crops. In addition to irrigation responsibilities, power generation is also an authorized purpose of American Falls Dam (Bureau of Reclamation Web site b). Ancillary benefits include: recreation use; fish and wildlife benefits, including water for flow augmentation in lower Snake and Columbia rivers to aid endangered and threatened anadromous fish; and flood control.

Land Use and Ownership

Land use includes cropland, pastureland, cities, suburbs, and industries (EPA et al. 2000). Agriculture, both irrigated and dryland, accounts for almost 40% of the land use in the subbasin (Table 1-9, Figure 1-8). Farmers grow small grains, sugarbeets, potatoes, and alfalfa mostly on irrigated land. Almost 50% of the area is rangeland, presently supporting primarily cattle. No other specific use accounts for more than 5% of the subbasin area.

Private landowners and BLM own over 60% of American Falls Subbasin (Table 1-10). Fort Hall Indian Reservation comprises 18.1% and Department of Energy (Idaho National Engineering and Environmental Laboratory) covers just over 11% of subbasin land (Figure 1-9). The remaining 8% is open water or State of Idaho and U. S. Forest Service lands.

Cultural Features, Population, and Economics

Most of the land area encompassed by American Falls Subbasin comprises three counties (Figure 1-1). Bannock County is the most populous, followed by Bingham and Power counties (Table 1-11). The largest city in the area is Pocatello with over 50,000 residents. Within the subbasin, major municipalities are Blackfoot, American Falls, Shelley, Aberdeen, and Firth. The population of the Shoshone-Bannock Tribes on Fort Hall Reservation is 4,820.

The three counties differ in their employment patterns. Manufacturing is responsible for almost half of the employment in Power County while jobs in Bingham and Bannock counties are more diverse (Table 1-12). The agriculture sector employs almost 20% of Power County, almost 9% of Bingham County, and about 1.5% of Bannock County workers. Government accounts for 20-30% of employees in all three counties. Food processing associated with the

potato industry is also prominent in the area with plants in American Falls, Blackfoot, Firth, and Shelley. Per capita income in all three counties is below both state and national averages.

Table 1-9. Land use in American Falls Subbasin and Bannock Creek watershed.

Land use	American Falls Subbasin		Bannock Creek watershed	
	Area (ac)	Percentage	Area (ac)	Percentage
Dryland agriculture	181,279	9.9%	95,823	36.2%
Forest	57,775	3.1%	48,420	18.3%
Irrigated - gravity flow	106,015	5.8%	3,963	1.5%
Irrigated - sprinkler	429,762	23.4%	9,481	3.6%
Rangeland	909,769	49.6%	105,694	39.9%
Riparian	21,710	1.2%	393	0.1%
Rock	74,485	4.1%	0	0.0%
Urban	4,404	0.2%	866	0.3%
Water	50,769	2.8%	231	0.1%

Table 1-10. Land ownership in American Falls Subbasin.

Land ownership	Area (ac)	Percentage
Bureau of Land Management	463,681	25.5%
Bureau of Indian Affairs	329,768	18.1%
Department of Energy	213,217	11.7%
Open water	58,625	3.2%
Private	660,865	36.4%
State of Idaho	83,184	4.6%
U. S. Forest Service	8,628	0.5%

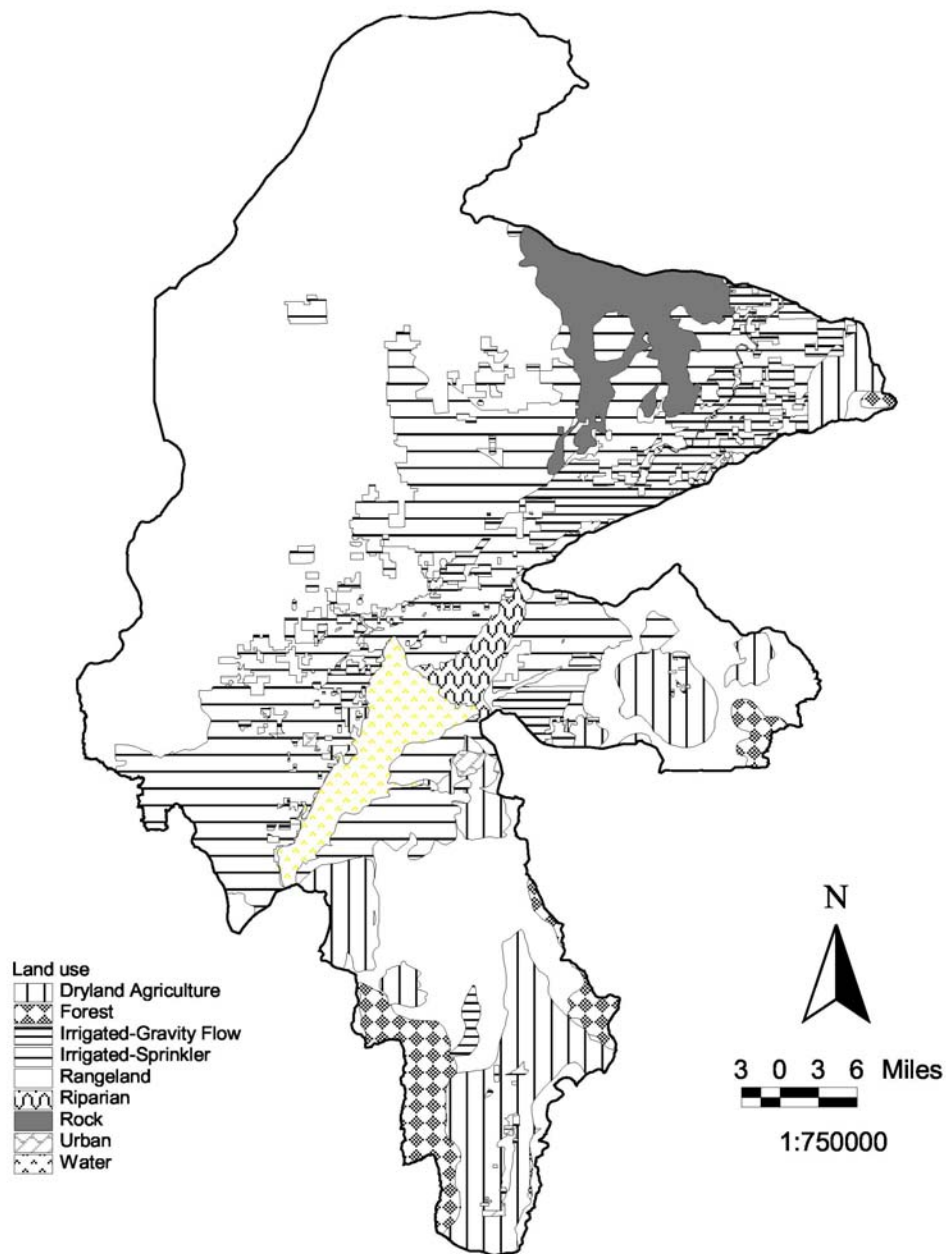


Figure 1-8. Land use in American Falls Subbasin (from Idaho Department of Water Resources GIS data sets).

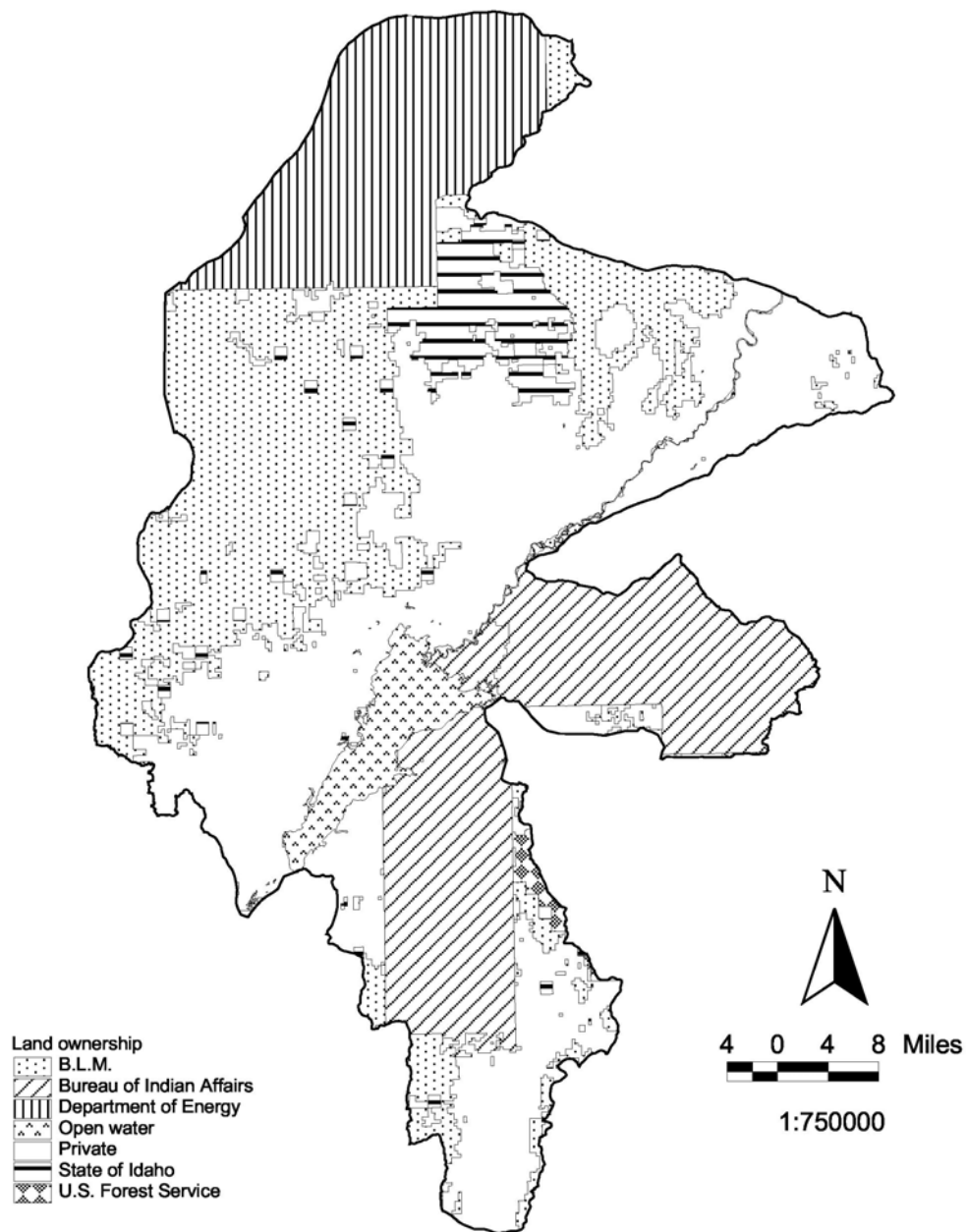


Figure 1-9. Land ownership in American Falls Subbasin (from Idaho Department of Environmental Quality GIS data sets).

Table 1-11. Population data for counties and cities in or near American Falls Subbasin (from Idaho Department of Commerce Web site).

County/city	Population		Percent change
	1990	2000	
Counties			
Bingham	37,583	41,735	11.0%
Power	7,086	7,538	6.4%
Bannock	66,026	75,565	14.4%
Municipalities			
Aberdeen	1,406	1,840	30.9%
American Falls	3,757	4,111	9.4%
Blackfoot	9,646	10,419	8.0%
Firth	429	408	-4.9%
Pocatello	46,117	51,466	11.6%
Shelley	3,536	3,813	7.8%

Table 1-12. Employment data for Bingham, Power, and Bannock counties, 2001 (from Idaho Department of Labor Web site).

County	Agriculture	Percentage of nonfarm payroll jobs ¹							Per capita income		
		Mining & construction	Manufacturing	T, C, & U ²	Trade	F, I, & RE ³	Services	Government	County	State of Idaho	United States
Bingham	8.7%	6%	18%	3%	28%	3%	11%	31%	\$19,340	\$24,506	\$30,413
Power	18.4%	7%	44%	8%	13%	2%	6%	20%	\$19,905	\$24,506	\$30,413
Bannock	1.4%	5%	8%	5%	25%	5%	25%	27%	\$21,780	\$24,506	\$30,413

¹because this section is based on a percentage of all nonfarm employment, summing these percentages with agriculture employment will result in a value greater than 100%

²transportation, communication, & utilities

³finance, insurance, & real estate

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There are thirteen (four municipal, four aquaculture, four CAFOs [confined animal feeding operations], one dairy) active or pending National Pollution Discharge Elimination System (NPDES) permitted dischargers in American Falls Subbasin (Figure 1-1, Table 1-13). The cities of Shelley, Firth, and Blackfoot release their effluent directly into the Snake River and Aberdeen discharges to Hazard Creek/Little Hole Draw, which empties into American Falls Reservoir. Three of the aquaculture NPDES permits are held by Crystal Springs fish hatchery. Indian Springs fish hatchery has one permit, but appears at present to not be in operation. American Falls Reservoir is the final disposition of Crystal Springs discharge while Snake River is the receiving water for Indian Springs. Large CAFOs (1000 animals or more) are required to have an NPDES permit, which dictates that they control their animal waste discharge. In American Falls Subbasin these include: Snake River Cattle Company, Tom Anderson Cattle Company, Bragg feedlot, and Kerry Ward feedlot. The only dairy with an NPDES permit in the subbasin is the Alan Andersen dairy.

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Table 1-13. National Pollution Discharge Elimination System permit holders or applicants in American Falls Subbasin (from EPA Web site and David Domingo, EPA/Seattle, personal communication).

Entity	Permit number	Permit issued date	Permit expired date	Description	Receiving waterbody
City of Aberdeen	ID0020176	Sep-01	Sep-06	Sewerage	Wasteway canal
City of Blackfoot	ID0020044	Oct-02	Nov-05	Sewerage	Snake River
City of Firth	ID0024988	Sep-87	Sep-92	Sewerage	Snake River
City of Shelley	ID0020133	Jun-88	Jun-93	Sewerage	Snake River
Indian Springs Hatchery	IDG130023	Aug-99	Sep-04	Fish hatchery	Snake River
Crystal Springs Trout Farm	IDG130038	Feb-00	Sep-04	Fish hatchery	Boon Creek
Snake River Cattle Company	IDG010069			CAFO ¹	none
Tom Anderson Cattle Company				CAFO ¹	none
Bragg feedlot				CAFO ¹	none
Kerry Ward feedlot				CAFO ¹	none
Alan Anderson dairy				dairy	none

¹CAFO=confined animal feeding operation

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